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Students' mathematical creative thinking ability in creative problem solving learning based on self-esteem

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Abstract

The purpose of this study was to determine the improvement of students' mathematical creative thinking ability and to describe students' mathematical creative thinking ability based on self-esteem. The method used in this study was mixed methods. The population in this study were seventh grade students in one of the junior high school in Semarang City. Through simple random sampling, the reseachers chose class VII A as an experimental class. Futhermore, 6 study subjects were interviewed consisted, covering 3 subjects from high self-esteem level and 3 subjects from low self-esteem level. The results of this study were: (1) student's mathematical creative thinking ability increased with a gain index of 0,4 and was included in medium level; (2) students with the high self-esteem level were categorized in level 4 of TBKM; and (3) students with the low self-esteem level were grouped in level 0 TBKM.

1. Introduction

Mathematics learning is generally carried out by teachers with a lot of emphasis on aspects of knowledge and understanding. Teachers have been implementing expository learninng more and practice solving the question quickly by using formulas that are directly given without understanding the concept deeply. This causes passsive and less students' creative to apply the concepts that have ben lerned in real life so the students cannot think creatively and cannot develop properly. According to the Ministry of Education and Culture (2013), students are expected to be able to express new ideas that are creative in analyzing and solving problems. One way to improve students's creativity in mathematics learning is to provide practice questions that can encourage students to analyse deeply to the problem and not give a benchmark in one way of solving or one answer. Evaluations in the form of different questions can be used so that students' mathematical creative thinking ability are further honed.

The process of thinking at a high level according to Purwanto (2007) is divided into five stages, namely (1) The emergence of problems, difficulties that must be solved, (2) Finding and collecting facts that are considered relevant to problem solving, (3) Level processing or digestion, facts processed and digested, (4) Level of discovery or understanding, finding ways to solve problems, (5) Assessing, refining and matching the results of solutions. In addition, Meyer, as quoted by Lince (2016), classifies thinking into three main components, namely (1) thinking is a cognitive activity that occurs in a person's mental or mind, not visible, but can be concluded based on observed behavior, (2) thinking is a process that involves a lot of manipulation of knowledge in the cognitive system. Knowledge is stored in memory with current information, thus changing one's knowledge of the situation at hand, and (3) thinking activities are directed to produce solutions to problems.

Creative thinking is mathematical thinking in solving mathematical problems. If students can solve routine math problems in a different way from the way taught by the teacher in class, then this student can be said to be creative in

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mathematics. According to Pehkonen (Siswono, 2011) creative thinking is a combination of logical thinking and divergent thinking based on intuition in consciousness. Logical thinking involves a rational and systemic process to examine and make conclusions. Whereas divergent thinking is considered as the ability to think, to look for ideas to solve problems. When someone applies creative thinking to solve problems, divergent thinking will generate new ideas. According to Azhari & Somakim (2014), creative thinking is the ability to see various possibilities of solving problems to a problem which is in form of thought that is still not getting attention in education.

According to Silver (1997), the creative thinking of children and adults is often assessed by using "The Torrance Tests of Creative Thinking (TTCT)". Three key components assessed in the creativity of using TTCT are fluency, flexibility, and novelty. Problem solving is one of the methods Silver uses to develop students' mathematical creativity. Students not only can become fluent in building many problems from a situation, but also they can develop a flexibility by generating many solutions to a problem. Through this way students can also be developed to produce new problem solving.

This study used the indicators of creative thinking ability according to Silver (1997), namely fluency, flexibility, and novelty. Each of these indicators in problem solving has characteristics. Fluency in problem solving refers to the ability of students to give diverse and correct answers. Answers are said to be vary if the answers appear to be different and follow certain patterns. The students' ability to produce diverse and correct answers, as well as students' difficulties in solving problems will also be explored to add the results of the description of students' creative thinking skills. Flexibility in problem solving refers to the ability of students to solve problems in different ways or approaches. Students can solve problems using one method or even other methods. Students are expected to be able to explain the settlement method used to solve related problems. The students' ability to change points of view to solve problems will also be explored to add the results of the description of students' level of creative thinking ability. Novelty in problem solving refers to students' ability to answer problems with different answers, but true value or one "unusual" answer is done by students at the level of knowledge.

The level of creative thinking is a level of made on the basis of categorization based on the product's ability to think creatively (creativity) by students. In determining the level of students' mathematical creative thinking, characteristics are needed as guidelines to say whether students are creative or not creative. This study used the level of mathematical creative thinking ability (MCTA) results of Siswono's research. Siswono (2011) states five levels of creative thinking in mathematics based on aspects of fluency, flexibility, and novelty, namely the level of mathematical creative thinking 4 (very creative), the level of mathematical creative thinking 3 (creative), the level of mathematical creative thinking 2 (quite creative), the level of mathematical creative thinking 1 (less creative), the level of mathematical creative thinking 0 (not creative).

Besides cognitive aspects, affective aspects also become the focus of mathematics learning which are related to students' creative thinking ability. Self-esteem is one aspect that is believed to contribute to student achievement. According to Happy (2014) learning is more effective if teachers cannot only develop cognitive aspects, but also affective aspects, especially students' self-esteem. Lo (2011) reveals that school is a place for teenagers to grow psychologically, develop, try to show themselves and the process of maturing themselves by building an impression about themselves and learning to behave appropriately. Rosenberg (The Morris Rosenberg Foundation, 2008) mentions that self-esteem is a positive or negative orientation of a person towards himself or can be said as a comprehensive evaluation of how a person assesses himself. In line with this, Guindon (2010) defines self-esteem as an attitude or evaluation (affective assessment) of individuals towards self-concept.

The level of self-esteem is divided into two, namely low level of self-esteem and high level of self-esteem. These levels result in differences in characteristics between individuals with low self-esteem and individuals with high self-esteem. According to Fadillah (2012) students are said to have low self-esteem if they believe and see that they are weak, unable to do anything, have no ability, tend to feel themselves always fail, unattractive, disliked and lose interest in life. Students with low self-esteem will tend to be pessimistic about the life and opportunities they face. He does not see challenges as opportunities, but rather as obstacles. He will easily give up

before trying, and if he fails, he would blame himself (negatively) or others. Conversely, students with high self-esteem will look more optimistic, confident and always be positive about everything, as well as the failures they experience. Failure is not seen as death, but rather makes it a valuable lesson to move forward. Students with high self-esteem will be able to respect themselves and see the positive things they can do for future success. This is consistent with Brockner's research as quoted by Guindon (2010) which shows that individuals with high self-esteem are more independent and more capable of directing themselves.

According to Pujiadi et al. (2015), the Creative Problem Solving (CPS) learning model is a learning model that focuses on learning and problem solving skills followed by strengthening skills. The CPS learning model according to Pepkin (2004) is a learning model that focuses on teaching and problem solving skills, that is followed by strengthening creativity. Students are accustomed to using creative steps in solving problems. When students are faced with a problem, they can do problem solving skills to choose and develop their ideas. In addition, students are also required to be active in CPS learning so that they are able to exclude their abilities to solve problems creatively. The CPS learning model has undergone development since it was introduced by Alex F. Osborn. During its history (more than 5 decades of research, development, and practical experience with groups), CPS has become a very dynamic model. Many experts have developed CPS from CPS Version 1.0 developed by Alex F. Osborn to the latest CPS Version 6.1 developed by Treffinger, Isaksen, and Dorval. In addition, CPS used in this study was CPS Version 6.1 with learning syntax according to Treffinger et al. (2010), namely (1) Understanding the Challenge, (2) Generating Ideas, and (3) Preparing for Action.

Based on the explanation above, the purpose of this study was to determine the improvement of students' mathematical creative thinking ability and to describe students' mathematical creative thinking ability based on self-esteem.

2. Methods

This study used mix methods with sequential explanatory design. In the first stage, the researches collected and analyzed quantitative data, conducted analysis of qualitative data by using one group pretest-posttest design.

The population in this study were seventh grade students in one of the junior high schools in the Semarang City, by simple random sampling, class VII A was selected as the research class. Furthermore, the subjects in this study were 6 students. The selection of research subjects was carried out by using purposive sampling technique. The determination of the subject of research was based on the results of the classification of the level of self-esteem. Hence, the researchers determined 6 students, consisting of 3 students from the low self-esteem level and 3 students from high self-esteem level.

Quantitative data analysis was taken from the results of the pretest and posttest, while students' creative thinking ability was tested through the tests of normality, homogeneity, and improvement. Further, the qualitative data analysis used three main steps, namely data reduction, data presentation, and conclusions.

3. Results & Discussion

Quantitative research data were tested by testing hypotheses. Before this, it was necessary to pre-test the prerequisites by testing the normality and homogeneity tests. Normality and homogeneity tests were carried out using the Kolmogorov-Smirnov test assisted by SPSS 22.0. The data obtained from the pretest and posttest results of the experimental class should be normally distributed and homogeneous.

The results of students' pretest and posttest scores can be seen in Table 1.

Table 1. Pretest and Posttest Scores

	N	Higher Score	Lower Score	Std. Deviation	Mean
Pretest	36	77	47	12.44	61.42
Posttest	36	88	64	9.97	76.86

Furthermore, the hypothesis test was conducted to find out the improvement of students' creative thinking ability after getting Creative Problem Solving learning. This was statistically tested by using paired samples t-test. In detail, the pired samples t-test results can be seen in Table 2.

Table 2. Paired Samples T-Test Results

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	*Pretest*	61.42	36	8	1.33
	Posttest	76.86	36	6.26	1.04

	Pired Differences					
	Mean	Std. Deviation	Std. Error Mean	T	Df	Sig. (2-tailed)
Pretest-Posttest	-15.44	2.99	4.99	-30.89	35	0.000

Paired samples t-test test results using SPSS 22.0 obtained the value of sig$= 0.000 < \alpha = 0.05$, so H_0 was rejected. It can be concluded that there were differences in the pretest and posttest scores. From the mean value, it can be seen that the average posttest value was higher than the pretest value. With this, it can be concluded that students' mathematical creative thinking ability have increased after Creative Problem Solving (CPS) learning.

Furthermore, an n-gain test was conducted to determine the magnitude of the increase in the pretest and posttest scores of mathematical creative thinking ability. The n-gain test in this study was carried out using MS-Excel program. Based on the calculation using the n-gain test formula proposed by Hake (1998) the researchers obtained the results of 0.40. This showed that the increase in students' mathematical creative thinking ability was 0.40, and included in the medium category. Therefore, it can be concluded that the improvement of students' mathematical creative thinking ability was included in the medium category.

The qualitative data in this study were analyzed using three main steps, namely data reduction, data presentation, and making conclusions. Data reduction was done by correcting the results of the posttest, analyzing the results of the self-esteem scale, and selecting the research subject for interview. Interviews were conducted to find out how students' mathematical creative thinking ability based on self-esteem.

Table 3. Summary of Mathematical Creative Thinking Ability

Level of Self-Esteem	**Indicators of Mathematical Creative Thinking Ability**		
	Fluency	**Flexibility**	**Novelty**
Low	Unable to solve the problem using more than one different solution fluently and correctly	Unable to solve the problem using more than one method of settlement with different methods / approaches correctly	Unable to solve the problem using the method itself correctly
High	Able to solve the problem using more than one different solution fluently and correctly	Able to solve the problem using more than one method of settlement with different methods / approaches correctly	Able to solve the problem using the method itself correctly

In this study the subjects of mathematical creative thinking ability with low levels of self-esteem were SR-1, SR-2, and SR-3. Based on the results of the analysis, it was concluded that the SR-1 subject was at MCTA level 2 which meant that the subject was quite creative because the analysis only fulfilled one indicator, namely the novelty indicator. SR-2 and SR-3 subjects were at MCTA level 0 which meant they were not creative because they have not fulfilled any indicators.

SR-1 have not met the indicators of fluency and flexibility, but have met the indicators of novelty. The item that contained the fluency indicator was item number 1, the item containing the indicator of flexibility were item number 2, 3 and 4, and the item containing the novelty indicator were item number 2 and 5. For item number 1, SR-1 was able to make planning correctly but has not been able to solve it. The cause of SR-1 has not been able to complete item number 1 can be seen from the results of the interview stating that SR-1 forgot how to do it. SR-1 also could not afford to improvise solving problems in their own way. For item number 2, the SR-1 tried to do it on his own unusual way, but there was a wrong resolution step so that SR-1 was not able to continue the completion step. When confirmed through interviews, the SR-1 subject

was aware that there was a wrong settlement step and was able to correct the answer correctly. For item number 3, SR-1 has been able to plan and solve problems correctly and answered in two ways of using different methods / approaches. However, the answers were not perfect because there were several steps that were not accompanied by information. During the interview, SR-1 was able to explain the answer smoothly and correctly. The information presented was also correct. SR-1 also understood the item number 3, it was just that it was difficult to write down the answer in detail. For item number 4, SR-1 was only able to solve the problem in one way. The method used was correct but not perfect because there were stages that were not written. After being confirmed through interviews, SR-1 was able to explain the answer smoothly and correctly. For item number 5, SR-1 has been able to solve the problem in two ways and both use their own methods. The method used was correct but not perfect because there were steps that were not written in detail. Yet, after the interview, SR-1 was able to explain the answer correctly.

SR-2 have not met the indicators of fluency, flexibility, or novelty. For item number 1, the SR-2 has not been able to make plans and also has not been able to solve the problem correctly. SR-2 did not understand so they experienced difficulties when working on item number 1. The explanation given at the interview was still wrong and SR-2 was also not sure of the answer himself. For item number 2, SR-2 has not been able to answer the question correctly. The results were correct but the method used was wrong. When confirmed through interviews, SR-2 turned out to be fabricated in answer because he could not work. For item number 3, SR-2 has been able to plan and solved problems correctly but only used one method of settlement. During the interview, SR-2 was able to explain the answer smoothly and correctly, the information conveyed was also correct. For item number 4, SR-2 was able to answer correctly but the completion steps were not perfect. There were still settlement steps that were not included and only used one method of settlement. After being confirmed through interviews, SR-2 was able to explain the answer smoothly and correctly. For item number 5, SR-2 was not able to complete.

SR-3 have not fulfilled all three indicators, namely fluency, flexibility, and novelty. For item number 1, SR-3 has not been able to answer the question correctly. When given problems in the form of descriptive, SR-3 has also not been able to make planning properly. The way of completion was coherent but the concepts used were not appropriate. When confirmed through interviews the answer was still wrong. For items number 2, 3 and 4, SR-3 used only one method and has not been able to answer the question correctly. The way to answer was coherent but the concepts used were wrong. When confirmed through interviews the answer was still wrong. For item number 5, he has not been able to answer the question correctly. He has been able to use his own way and the answer has also been coherent but the concepts used were wrong. When confirmed through interviews the answer was still wrong.

In this study the subjects of mathematical creative thinking ability with high levels of self-esteem were ST-1, ST-2, and ST-3. Based on the results of the analysis, the researchers concluded that the subject ST-1, ST-2, and ST-3 were at MCTA level 4 which meant they were very creative because they met all indicators, namely indicators of fluency, flexibility, and novelty.

ST-1 has fulfilled all indicators, namely fluency, flexibility, and novelty. For item number 1, the ST-1 was able to answer the question correctly but only used one method. When given a descriptive problem, ST-1 was able to plan properly and was able to solve it. The settlement was not perfect because the reasons and information were not included. When interviewed, ST-1 was able to explain the answers that had been written fluently and correctly. ST-1 could also complete item number 1 with a different solution. The explanation given was correct and the answer given was correct. Thus, ST-1 was able to solve item number 1 correctly using two different solutions. For item number 2, ST-1 was able to answer using his own method correctly even though only in one way. The answer was correct but there were several steps that have not been accompanied by a description. When interviewed, ST-1 was able to explain the answer correctly and was able to answer using two methods with different methods / approaches. For item number 3, ST-1 has been able to plan and solve problems correctly but only used one method and there were still several steps that were not accompanied by information. ST-1 understood and did not experience difficulties in completing item number 3. During the interview, ST-1 was able to explain the answer correctly and could also answer using different methods / approaches in the previous way. Both of the methods used were correct. For item number 4, ST-1 was able to answer correctly

but was not perfect because there were steps that are not accompanied by information and only used one method. During the interview, ST-1 was able to explain the answer correctly and could also answer using a method with a different method / approach in the previous way. For item number 5, ST-1 was able to solve the problem using his own method correctly. However, there were several steps that have not been accompanied by information. During the interview, ST-1 was able to explain the answer fluently and correctly.

ST-2 has fulfilled all indicators, namely fluency, flexibility, and novelty. For item number 1, ST-2 has been able to solve the problem using two different ways. The first method was correct but in the second way there was a slight error. When given problems in the form of descriptive, ST-2 was also able to make planning correctly. When confirmed through interviews, ST-2 was able to explain the answer fluently and correctly and find out where the mistake is. For item number 2, he was able to answer using its own method in two ways correctly, but the method of resolution was not written systematically. During the interview, ST-2 was able to explain coherently and correctly how to solve item number 2. For item number 3, ST-2 was able to plan and solve the problem correctly and answer in two ways of solving using the method / approach that different. However, there were several steps that were not accompanied by information and in the second way the solution was not written systematically. During the interview, ST-2 was able to explain coherently and correctly how to solve item number 2. For item number 4, ST-2 was able to answer using two different ways. Yet, the way to solve was not written in detail. After being interviewed, ST-2 was able to explain in detail and correct both ways of settlement. For item number 5, ST-2 has been able to solve the problem using his own method correctly. Unfortunately, there were several steps that have not been accompanied by information. During the interview, ST-2 was able to explain correctly the answers written.

ST-3 has fulfilled all the indicators of fluency, flexibility and novelty. For item number 1, ST-3 has been able to solve the problem using two different ways correctly. But the answer is less than perfect, there is a slight error in writing the name of the corner. When confirmed through interviews, ST-3 was able to explain the answer back fluently and correctly and find out where the mistake was. For item number 2, ST-3 is able to solve the problem using three methods with different methods / approaches and using his own method. The settlement method has been coherent and has been accompanied by the correct information. During the interview, ST-3 was also able to explain the answers already written. For item number 3, ST-3 has been able to plan and to solve problems correctly and answer in two ways of using different methods / approaches. During the interview, the subject was able to explain the answer fluently and correctly. For item number 4, ST-3 was able to answer item number 4 correctly using two methods with different approaches. During the interview, he was able to explain the answer fluently and correctly. For item number 5, ST-3 has been able to solve the problem using his own method correctly. In the interview, the ST-3 subject was able to complete using two methods correctly. The method used was his uncommon one.

4. Conclusion

Based on the results of research and discussion, conclusions can be drawn as follows.

1. Mathematical creative thinking abilities of students who were taught using the Creative Problem Solving learning model has an increase with a gain index of 0.40, and can be categorized into medium category.
2. Students' creative thinking abilities in Creative Problem Solving learning based on self-esteem are as follows.
   a. Students with low self-esteem are classified as MCTA level 0 (not creative) because they have not been able to solve problems correctly using more than one different solution (fluency), solve the problem correctly using more than one solution with a different approach / method (flexibility), and has not been able to solve the problem correctly using their own unusual way (novelty).
   b. Students with high self-esteem are classified as MCTA level 4 (very creative) because they are able to solve problems correctly using more than one different solution (fluency), able to solve problems correctly using more than one method of settlement with an approach / different methods (flexibility), and able to solve problems correctly using their own unusual way (novelty).

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